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**EVALUATION OF SELECTIVE
STRIPPING TECHNOLOGY**



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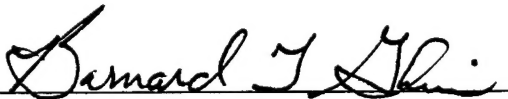
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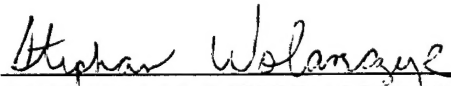
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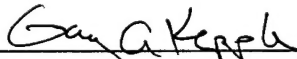
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EXECUTIVE SUMMARY

Title:	Evaluation of Selective Stripping Technology
AF Customer:	Air Force Research Laboratory, Coatings Technology Integration Office
Report Period:	October 1998 – June 2000

1.0 Introduction

Southwest Research Institute has completed a test program assessing dry media blast (DMB) selective stripping of a coating system originally developed to work well with high-pressure water blast stripping. The design of this system is such that the topcoat is selectively removed, leaving an intermediate barrier coating intact. Since the barrier has not been damaged, the underlying primer coating has been protected, and there is no toxic waste associated with this stripping process because the primer is the only component of the system containing toxic materials. The goal of this project was to determine any feasibility of using a DMB process for selective stripping of the topcoat from the coating system containing the barrier coating.

2.0 Approach

DMB processes used for this assessment were based on readily available media. DMB processes, based on several media, were varied in attempts to achieve acceptable selective stripping. Selective stripping was considered acceptable if the topcoat was removed with no or very minimal damage to the barrier coating.

3.0 Results

In general, there was limited acceptable selective stripping with the DMB processes evaluated by this project. The only process tested in this project that showed any significant success was based on a sponge-like media, Sponge Jet[®] Silver Media. A similar media had been assessed earlier in the project, but without the same control of the process parameters, and also without benefit of more sophisticated equipment specifically designed for the media. It is thought that these improved process controls contributed to the successful selective stripping observed with this process. None of the other media/process combinations appeared to offer much hope of successful selective stripping.

4.0 Conclusions/Recommendations

In the development of the barrier system, Battelle Memorial Institute has developed test data that suggests that the most effective selective stripping with the water blast process is achieved after conditioning test materials with UV light¹, which is intended to simulate exposure to natural sunlight. The test materials used for these assessments under this new SwRI activity did not

¹ J. T. Stropki, R.L. Wolterman, R.E. Russell III, and R.I. Slife, "Weatherability Assessment of a Barrier Coating System", Proceedings of the DoD/Industry Aerospace Coatings Conference, May, 1999.

undergo this conditioning. It has been suggested by Battelle that test results associated with the SwRI project may be influenced by this lack of conditioning. It is difficult to determine whether the lack of larger scale feasibility is attributable to this factor, or whether the nature of the coating system is such that feasibility for DMB selective stripping is limited by other factors such as the formulation of the barrier coating.

A better understanding of the effect of coatings aging is needed to determine the real feasibility of DMB selective stripping. The results seen with one media/process combination suggests that DMB selective stripping is possible, but integration of this coating system into Air Force operations using DMB stripping will not be feasible without a more thorough assessment of aging effects on the strippability. Once these effects are studied, the coating system for use with DMB processes would most likely need optimization, which may include reformulation of the basic resin system of the barrier coating to improve the selective with DMB stripping processes.

EVALUATION OF SELECTIVE STRIPPING TECHNOLOGY

1.0 INTRODUCTION

Current Air Force coatings systems, as applied to bare metal substrate, are comprised of a chromated primer covered with one or more overcoatings to form the complete system. During periodic aircraft maintenance, and sometimes field repair, the coating system is removed to perform some types of maintenance. The application of chromated primers produce VOCs, and the removal of these chromated materials creates a large toxic waste stream in combination with spent depaint materials such as plastic media, chemical strippers, and other solid waste.

A reduction of these toxic products may be accomplished through the use of special release coatings and/or removal techniques that do not disturb the chromated primer while still allowing the maintenance to be performed. The Warner Robins Air Logistics Center (WR-ALC) approach has demonstrated a potential for an intermediate or barrier coating that permits the removal of the topcoat, while protecting the chromated primer from damage (removal) when used in conjunction with a pressurized water blast depaint system.

A barrier coating system is being considered for use by the Air Force. This coating system was developed by Battelle under contract with WR-ALC/TIEDM, and was formulated for removal through the use of a high-pressure water blast procedure. It was desired to see if any of the readily available dry media could produce similar results to water blasting. The media/processes evaluated by this project were Type V, Type I, U.S. Technology Sponge BlastTM, and Sponge-Jet[®] Silver.

A number of process parameters influence the strippability of the media. Blast pressure, media flow rate (MFR), standoff distance (SOD), angle of impingement, and traverse rate are the primary variables of DMB processes. These parameters were varied to affect stripping of the topcoat and leaving the barrier coat intact. This effort was not a true optimization of any one process, but an evaluation of the feasibility of various media/process parameters combinations to selectively remove the topcoat without disturbing the barrier layer.

2.0 TEST APPROACH

2.1 Media Flow Rate Calibration

The dry media booth at WR-ALC is equipped with an auger valve manufactured by Pauli Systems, Inc. and is equipped with a dial-in valve controller which has a range of 0-100% for the valve speed. As the valve rotates, an opening allows media to fall into the blast stream. As the speed of the valve and its subsequent rotation increases, more media is allowed into the blast stream, which gives higher media flow rates. The difficulty is that different media types will have different corresponding MFRs over the range of the valve speed due to differences in density and particle size. In order to have repeatability between blasts and the convenience of

using the dial-in controller, an accurate relationship between the controller and the actual MFR is needed for each media type.

To develop this relationship, media was blasted into a steel drum specially designed to remove the air buildup by venting the blast air out of the drum through a filter bag that retains the media in the drum. The blasting was timed for one minute and the media was then transferred cautiously to a bucket and weighed using a hook scale. This procedure was performed three times each at 10%, 30%, 50%, 70%, and 90% flow. The weight of the bucket was subtracted from each value and then the three values were averaged. A linear graph was produced from the results and became the reference from which all MFRs were determined. This calibration was performed for every media type prior to testing. The dry booth and hoses were thoroughly cleaned of used media before a new type was introduced to the system. Furthermore, effort was made to move from less aggressive to more aggressive media types to minimize any damaging effect of residual media that remained in the system after cleanup. The only exception is that testing at WR-ALC began with the most aggressive media of those studied, Type V, because it was already loaded into the dry media booth.

2.2 Selective Stripping Effectiveness

Stripping effectiveness assessments were conducted with a venturi nozzle (VN) typically used in Air Force coatings removal operations, and with a double venturi nozzle (DVN) for Type I media, Sponge Blast™ and Sponge-Jet® media. In some instances as noted below, a fan nozzle was also used for limited assessments to investigate the possibility that a significantly different nozzle design might have some effect on acceptable strippability.

Traverse rates were controlled by the XY translation stage control system and recorded. The various types of media react differently to changes in the process parameters, and so it was necessary to make decisions about parameter changes after each blast on the test panel. The goal was to find parameters that approached the smooth, uniform stripping of the water-based process. In most cases, testing was suspended when it became apparent that the media was incapable of removing the topcoat layer in a uniform manner and without damaging the barrier coating.

Two primer/topcoat combinations were used. S1 is the designation for the standard polyurethane system and uses the MIL-P-23377G, Type 1, Class 2 primer. Type S2 uses the urethane primer, TT-P-2760, Type 1, Class 2. Specific data on coatings used including manufacturer, product name, lot number, and application data was not requested from Battelle, but the materials used for preparations of the SwRI test panels are believed to have been used by Battelle in studies conducted by Battelle. Panels were labeled as "S.x.y." where S stands for set, x is the primer/topcoat system, and y is in numerical sequence of the panel marked as needed by the testing.

Strip rate data was only determined for those instances when stripping effectiveness approached, or met acceptable selective stripping criteria. Strip areas were based on the width of the area

stripped successfully (or nearly successfully) and were multiplied by traverse rates times to derive area stripped per second. Multiplying this number by 60 sec/144 in² yields a strip rate value of ft²/min. Successful selective stripping was judged to be the majority of the topcoat removed within the blast footprint defined by each nozzle, with no or very minimal barrier coating damage as determined by visual observations. An acceptable selective strip rate of 0.75 ft²/min has been cited in the project Test Plan.

3.0 RESULTS

3.1 Type V Media

The flow controller was calibrated for Type V (MIL-P-85891A) media using the procedure outlined in Section 2.1. The resulting graph of the media flow rate over the range of the valve is shown below in Figure 3.1.1.

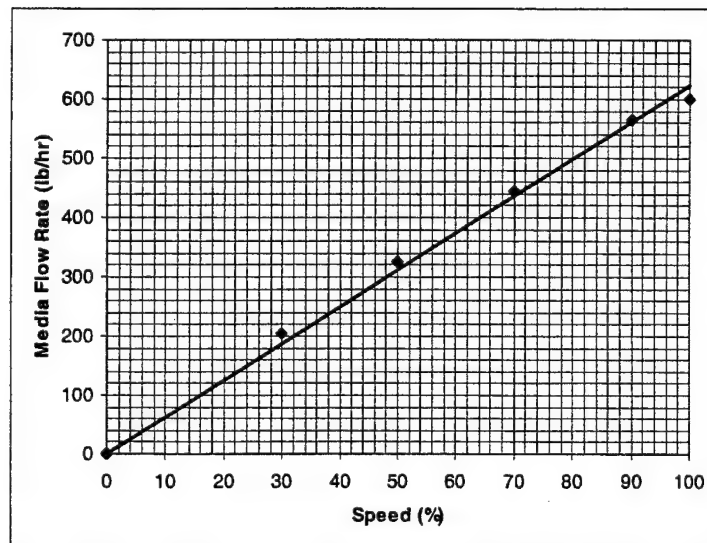


Figure 3.1.1 Flow Controller Calibration Using Type V Media (30/40 mesh)

After performing a successful calibration, testing began on the panels. The panels were mounted on a fixed frame in the dry media blast booth. The nozzle was aligned using a level, and the standoff distance was verified with a tape measure. A needle gauge was inserted into the air hose at the nozzle holder, blasting commenced, and the blast pressure was adjusted to the desired value. These steps were repeated multiple times as process parameters were changed. The process parameters were entered into the lab notebook and also on the panels themselves using a permanent marker. An objective description of the strip quality was also noted in the lab notebook. The data for Type V media for S1 and S2 test materials are presented below in Table 3.1.1 and Table 3.1.2, respectively.

Table 3.1.1 Selective Stripping Using Type V Media, S1 Panels

SOD, in	Angle, deg	Pressure, psi	v, in/sec	Nozzle	MFR, lb/hr	Stripping Results
21	60°	30	0.8	VN	600	complete removal of the coating system to bare substrate
21	60°	30	0.8	VN	325	complete removal of the coating system to bare substrate
21	60°	30	1.6	VN	325	complete removal of the coating system to bare substrate
21	60°	20	1.0	VN	325	complete removal of the coating system to bare substrate
21	45°	20	1.6	VN	325	complete removal of the coating system to bare substrate
21	45°	15	1.6	VN	325	complete removal of the coating system to bare substrate
21	45°	15	1.2	VN	325	complete removal of the coating system to bare substrate
21	45°	15	1.4	VN	325	complete removal of the coating system to bare substrate
21	45°	15	1.4	VN	325	complete removal of the coating system to bare substrate
21	45°	15	1.6	VN	325	complete removal of the coating system to bare substrate
21	90°	15	1.2	VN	325	complete removal of the coating system to bare substrate
21	90°	15	1.6	VN	325	complete removal of the coating system to bare substrate
21	90°	15	2.5	VN	325	complete removal of the coating system to bare substrate
21	45°	15	1.6	VN	260	90% topcoat removed, barrier and primer damage showing
21	30°	15	1.6	VN	260	90% topcoat removed, barrier damage, primer showing
21	35°	15	1.6	VN	260	specks of topcoat residue, with damage to barrier and primer
21	35°	15	1.6	VN	260	50% topcoat removal, significant barrier erosion
24	60°	15	1.6	VN	260	40% topcoat removal, significant barrier erosion
30	60°	20	1.6	VN	325	60% topcoat removal, barrier and primer erosion
30	60°	15	1.6	VN	325	30% topcoat removal, barrier and primer erosion
30	60°	15	1.6	VN	470	40% topcoat removal, barrier and primer erosion
30	60°	10	1.6	VN	470	30% topcoat removal, barrier and primer erosion
30	45°	15	1.0	VN	600	50% topcoat removal, barrier erosion
36	60°	20	1.6	VN	470	40% topcoat removal, barrier and primer erosion

Table 3.1.2 Selective Stripping Using Type V Media, S2 Panels

SOD, in	Angle, deg	Pressure, psi	v, in/sec	Nozzle	MFR, lb/hr	Stripping Results
30	60°	15	1.6	VN	325	30% topcoat removal, no barrier damage
30	60°	15	1.4	VN	325	30% topcoat removal, no barrier damage
30	60°	15	1.2	VN	325	40% topcoat removal, no barrier damage
30	60°	15	1.0	VN	325	40% topcoat removal, no barrier damage
30	60°	15	1.0	VN	470	80% topcoat removal, barrier and primer damage
30	60°	15	1.0	VN	600	70% topcoat removal, some barrier damage
30	45°	15	1.0	VN	600	80% topcoat removal, barrier damage
30	45°	15	1.0	VN	600	80% topcoat removal, barrier and primer damage
30	45°	15	1.0	VN	600	80% topcoat removal, barrier and primer damage
30	45°	15	1.0	VN	600	20% topcoat removal, no barrier damage
30	45°	15	1.0	VN	600	20% topcoat removal, no barrier damage
30	45°	15	1.0	VN	600	70% topcoat removal, some barrier damage
33	60°	15	1.0	VN	470	50% topcoat removal, some barrier damage
33	60°	15	1.0	VN	600	10% topcoat removal, no barrier damage

Type V media was found to be too aggressive on both primer systems. Visual inspection showed non-uniform strips with varying degrees of damage. Stripping results were also not consistent between different panels with the same primer coating. The cause of the inconsistencies is presumed to be associated with the coating system, since the depaint process was well controlled. These observations are illustrated in Figures 3.1.2 and 3.1.3. Passes 9 through 12 on a S2 panel showed the best results of all the Type V attempts (Figure 3.1.4), but the blasts still show non-uniform stripping with random specks of topcoat, barrier, primer, and bare substrate at the edge of the test panel. It was decided to cease Type V testing, after further attempts did not improve the quality of the stripping.

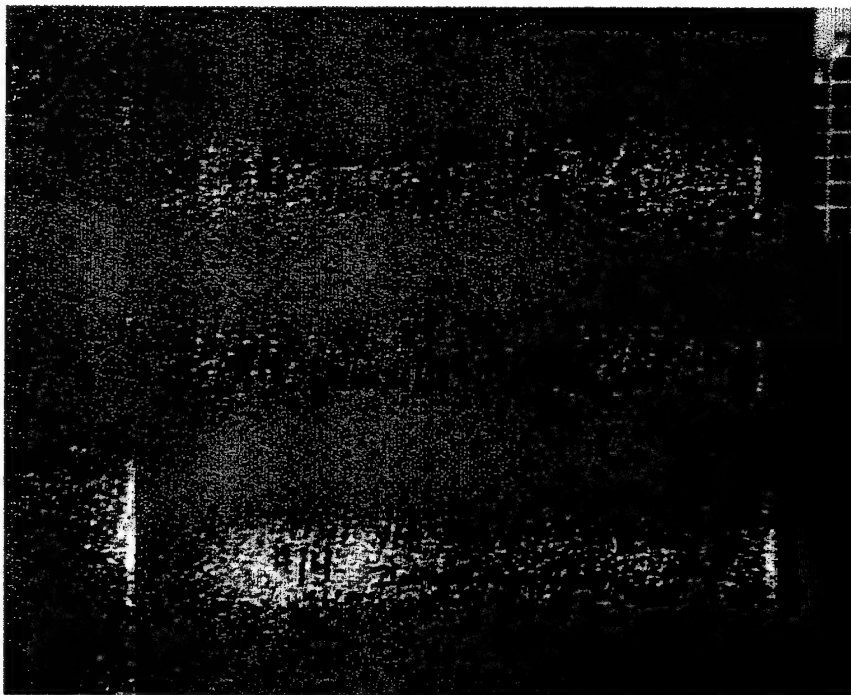


Figure 3.1.2 Type V DMB on S1 Test Panel

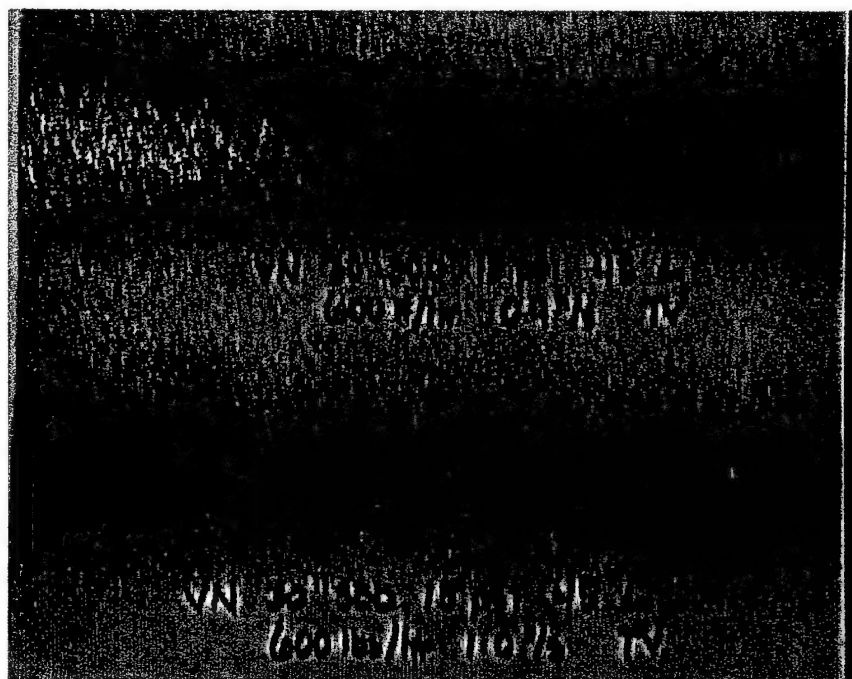


Figure 3.1.3 Type V DMB on S2 Test Panel



Figure 3.1.4 Type V DMB on S2 Test Panel with Best Strippability Results

3.2 Type I Media

Type I (MIL-P-85891A) media is a less aggressive media than Type V. To minimize residual traces of Type V media from influencing further testing, the dry media booth was carefully cleaned and purged of Type V media. This cleanout included removing the bellows from the robot x-stage and cleaning the x-stage internals thoroughly. When completed, the booth was recharged with Type I media and allowed to run through a blast and reclamation cycle before testing on test materials began.

At this time, it was necessary to recalibrate the flow controller. The procedure used was the same as for the Type V media. The calibration data was again graphed and fitted to a linear relationship. This graph was used to set flow rates into the flow controller.

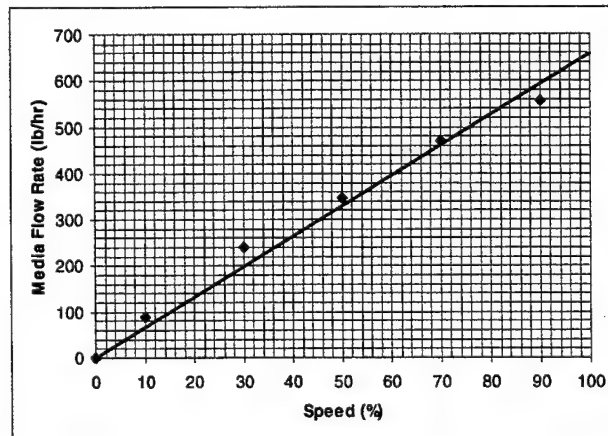


Figure 3.2.1 Flow Controller Calibration Using Type I Media

The data for Type I media and S1/S2 test materials were obtained in the same manner as the Type V data with the exception that the double venturi nozzle was the primary used for this assessment per the recommendations of U.S. Technology, the media manufacturer. These data are presented below in Table 3.2.1 and Table 3.2.2, respectively.

Table 3.2.1 Selective Stripping Using Type I Media, S1 Panels

SOD, in	Angle, deg	Pressure, psi	v, in/sec	Nozzle	MFR, lb/hr	Stripping Results
8	45°	25	3.0	DVN	330	90% removal of the topcoat, barrier damage
8	45°	25	3.5	DVN	330	90% removal of the topcoat, barrier damage
8	45°	25	4.0	DVN	330	90% removal of the topcoat, barrier damage
8	45°	25	2.0	DVN	330	90% removal of the topcoat, barrier damage
8	45°	25	2.5	DVN	330	90% removal of the topcoat, barrier damage
8	45°	25	3.0	DVN	330	90% removal of the topcoat, barrier damage
8	45°	25	1.1	DVN	170	10% removal of the topcoat, no barrier damage
8	45°	25	1.3	DVN	170	no stripping, topcoat roughened
8	45°	25	1.5	DVN	170	no stripping, topcoat roughened
8	45°	25	3.0	DVN	650	90% removal of the topcoat, barrier damage
8	45°	25	3.5	DVN	650	90% removal of the topcoat, some barrier damage
8	45°	25	4.0	DVN	650	80% removal of the topcoat, some barrier damage
8	60°	25	4.0	DVN	650	90% removal of the topcoat, barrier damage
8	60°	25	4.5	DVN	650	90% removal of the topcoat, some barrier damage
8	60°	25	5.0	DVN	650	80% removal of the topcoat, some barrier damage
12	45°	25	1.0	VN	330	topcoat removed, significant barrier erosion
12	45°	25	2.0	VN	330	40% topcoat removal, no significant barrier erosion
12	45°	25	1.8	VN	330	40% topcoat removal, no significant barrier erosion
12	45°	25	1.6	VN	330	80% topcoat removal, barrier erosion
12	45°	25	2.5	FAN	480	no topcoat removal
12	45°	25	1.5	FAN	480	5% topcoat removal, no barrier damage
12	45°	25	1.75	FAN	480	5% topcoat removal, no barrier damage
12	45°	25	2.0	FAN	480	5% topcoat removal, no barrier damage
12	45°	25	2.0	DVN	650	90% removal of the topcoat, some barrier damage
12	45°	25	2.5	DVN	650	90% removal of the topcoat, some barrier damage
12	45°	25	3.0	DVN	650	60% removal of the topcoat, some barrier damage
12	60°	25	4.0	DVN	650	30% topcoat removal, some barrier damage
12	60°	25	4.5	DVN	650	10% topcoat removal, no barrier damage
12	60°	25	5.0	DVN	650	10% topcoat removal, no barrier damage
12	60°	25	4.0	DVN	650	80% removal of the topcoat, some barrier damage
12	60°	25	4.5	DVN	650	70% removal of the topcoat, some barrier damage
12	60°	25	5.0	DVN	650	70% removal of the topcoat, some barrier damage
16	45°	25	1.6	DVN	330	90% removal of the topcoat, barrier damage
16	45°	25	1.0	DVN	650	90% removal of the topcoat, barrier damage
16	45°	25	1.5	DVN	650	90% removal of the topcoat, some barrier damage
16	45°	25	2.0	DVN	650	60% topcoat removal, no barrier damage

Table 3.2.2 Selective Stripping Using Type I Media, S2 Panels

SOD, in	Angle, deg	Pressure, psi	v, in/sec	Nozzle	MFR, lb/hr	Stripping Results
8	45°	25	3.0	DVN	330	90% removal of the topcoat, barrier damage
8	45°	25	3.5	DVN	330	90% removal of the topcoat, barrier damage
8	45°	25	4.0	DVN	330	90% removal of the topcoat, barrier damage
8	45°	25	2.0	DVN	330	90% removal of the topcoat, barrier damage
8	45°	25	2.5	DVN	330	90% removal of the topcoat, barrier damage
8	45°	25	3.0	DVN	330	90% removal of the topcoat, barrier damage
8	45°	25	1.1	DVN	170	10% removal of the topcoat, no barrier damage
8	45°	25	1.3	DVN	170	no stripping, topcoat roughened
8	45°	25	1.5	DVN	170	no stripping, topcoat roughened
8	45°	25	3.0	DVN	650	90% removal of the topcoat, barrier damage
8	45°	25	3.5	DVN	650	90% removal of the topcoat, some barrier damage
8	45°	25	4.0	DVN	650	80% removal of the topcoat, some barrier damage
8	60°	25	4.0	DVN	650	90% removal of the topcoat, barrier damage

In general, the selective strip results observed with Type I media was much the same as seen with Type V media DMB. Figures 3.2.2 and 3.2.3 show fairly typical results from testing conducted at WR-ALC. This testing indicated it was very difficult to achieve good topcoat removal without also producing barrier damage. Figure 3.2.4 is a picture of a panel stripped manually by U.S. Technology with the same media that is very acceptable. This effort was conducted independently from CTIO efforts, and CTIO efforts were meant to try to replicate this accomplishment based on the process parameters supplied by U.S. Technology with no significant success.

The primary differences between the panels stripped by U.S. Technology is that the coating system on the test panel supplied to U.S. Technology was substantially older than the CTIO test materials, and possibly a different batch of coating materials was used for this panel versus the CTIO test materials. All test materials were prepared by Battelle, and data to substantiate panel differences were not requested from Battelle.



Figure 3.2.2 Type I DMB on S1 Test Panel



Figure 3.2.3 Type I DMB on S2 Test Panel

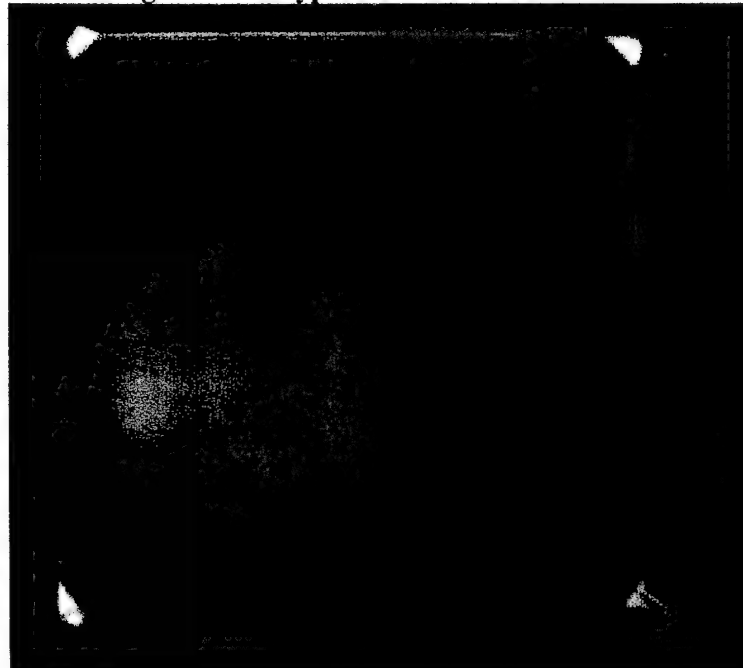


Figure 3.2.4 Type I DMB on S1 Type Panel Done by U.S. Technology

3.3 Sponge Blast™ Media

Testing with a new media produced by U.S. Technology Corporation was conducted at their facilities. These efforts were observed and documented by SwRI. The media used for conducting these tests is a urethane foamed 'sponge,' which encapsulates aluminum oxide grit. The aluminum oxide grit used for this assessment was 320 mesh. Testing was conducted within a glove box type blast booth, using a double venturi nozzle per U.S. Technology recommendations, and actual blasting was done by Mr. Dan Kinsinger, U.S. Technology. Blasting was done in a manual mode, and all process parameters are given as approximations since, when blasting in a manual mode, physical parameters tend to vary.

Process parameters used during these trials were varied in an attempt to achieve acceptable selective stripping. Barrier coating damage ranged from erosion of the barrier through to the primer, and in several instances, removal of barrier and primer to the substrate. The impression derived from observing these test efforts was that it was difficult to manually control the DMB process, and that there was little margin of error. Minor over-blast and/or attempts to completely remove the topcoat through directing the blast stream over an area previously blasted typically produced, at minimum, some degree of barrier damage.

Test results are tabulated below:

Table 3.3.1 Selective Stripping Trials with Sponge Blast™ Media

SOD, in	Angle, deg	Pressure, psi	Nozzle	MFR, lb/hr (estimated)	Stripping Results
12	30°	40	DVN	600	40% removal of the topcoat, barrier and primer damage
12	30°	20	DVN	600	90% removal of the topcoat, some barrier damage
12	30°	45	DVN	600	50% removal of the topcoat, barrier damage
12	30°	45	DVN	600	50% removal of the topcoat, barrier and primer damage
12	60°	45	DVN	300	80% removal of the topcoat, significant barrier damage
12	60°	45	DVN	600	80% removal of the topcoat, significant barrier damage
12	15°	45	DVN	600	80% removal of the topcoat, significant barrier damage
18	15°	35	DVN	600	70% removal of the topcoat, barrier damage

Selective strip results with this media/process combination did not appear to be favorable. Figures 3.3.1 and 3.3.2 show typical results on S1 and S2 test materials respectively.

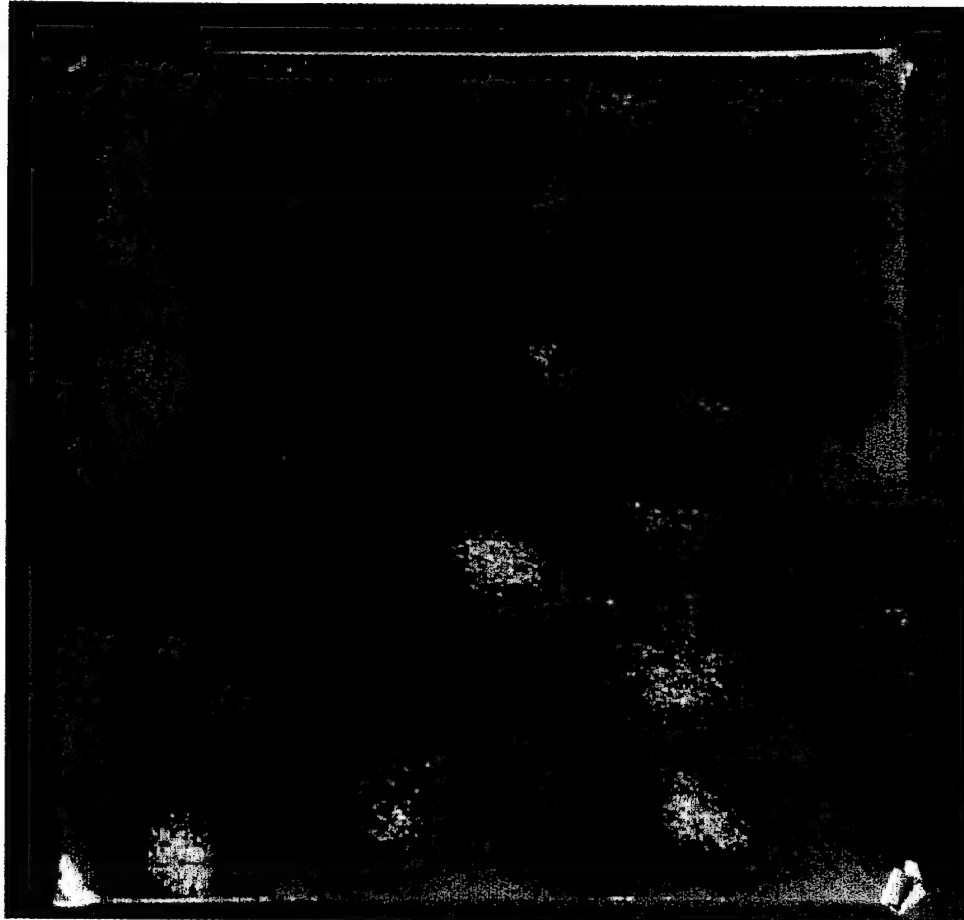


Figure 3.3.1 Sponge Blast™ DMB on S1 Test Panel

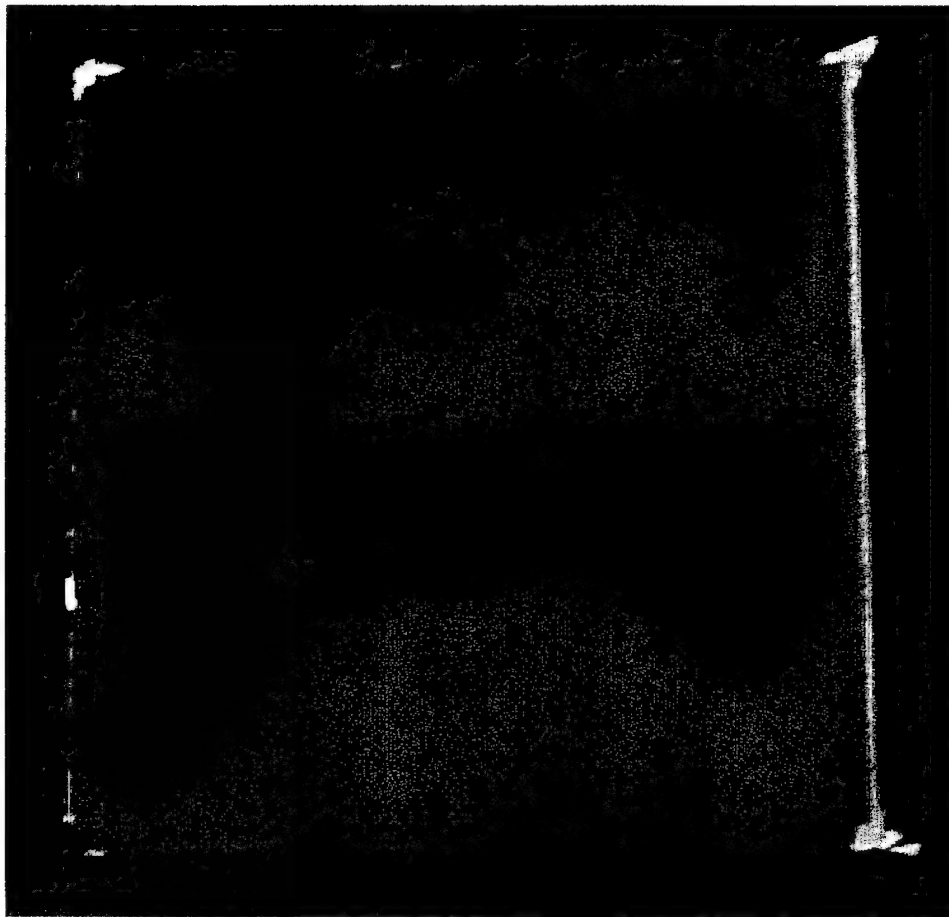


Figure 3.3.3 Sponge Blast™ DMB on S2 Test Panel

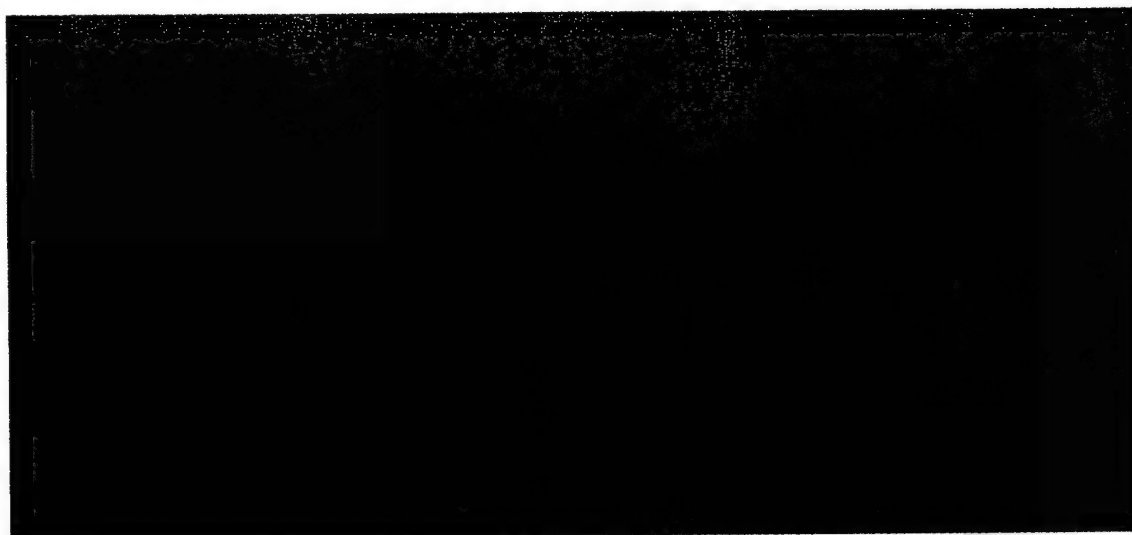
3.4 Sponge-Jet® Silver Media

The Sponge-Jet® media was the last media/process tested. The Sponge-Jet® Silver Media is believed to be ostensibly the same as the Sponge Blast™ media. Sponge-Jet® Silver Media also is 320 grit aluminum oxide grit encapsulated by a soft plastic. A stand-alone Sponge-Jet® unit was used instead of the standard media feed system. (The standard media feed system includes the Pauli media flow valve incorporated into the dry media blast booth system.) The Sponge-Jet® blast system incorporates an auger feed system that is pneumatically driven, and a special device within the feed pot that keeps the media agitated to prevent media from clogging the feed system.

In order to use the Sponge-Jet® blast unit for this assessment the same hose and nozzle(s) assembly used for other assessments was fitted to the Sponge-Jet® unit and secured inside the booth using the nozzle fixture on the y-stage. The inside of the booth was lined with plastic to prevent the sponge media from entering the reclamation system of the dry booth, and blasted media was collected and reused in a ratio of 3 parts used to 1 part new as recommended by the manufacturer.

It was desired to find an approximate MFR of 600 lbs/hr to reproduce work previously conducted at U.S. Technologies with the similar media. The blast pressure was set at 40 psi and the auger drive pressure at 50 psi. Three weight measurements were made of the sponge media with the same blast drum setup used previously. Samples were collected for an elapsed blast period of 1 minute. These air pressure settings produced an MFR equal to 10.375 lb/min or 620 lbs/hr. This MFR was deemed acceptable for the testing of the media.

The test results with this media/process were encouraging in that this assessment demonstrated some tangible level of feasibility of successful DMB stripping. The Sponge-Jet® Silver Media/process was able to remove the topcoat layer without disturbing the barrier coating during several test passes. The results appeared to be dependent on the coating thickness, since many panels showed acceptable stripping on a portion of a given strip footprint, while being unacceptable on the remaining portion of the footprint. As with previous assessments, stripping results were not as repeatable as would be desired. Strip rate data were calculated on a limited basis for this media/process, since it was observed to show signs of acceptable selective stripping at several sets of process parameters. These strip rate data and other data developed in this assessment are shown below for S1 and S2 type test materials in Table 3.4.1 and Table 3.4.2 respectively.



**Figure 3.4.1 Sponge Jet® Silver Media DMB using Double Venturi Nozzle
on S1 Test Panel with Acceptable Stripping**



**Figure 3.4.2 Sponge Jet® Silver Media DMB using Fan Nozzle
on S1 Test Panel with Reasonable Stripping**

In general this process seemed to work best with the S2 test materials. Testing with the S1 materials show more limited success with the double venturi and fan nozzles (Figures 3.4.1 and 3.4.2), while better stripping was observed with both fan nozzles (Figures 3.4.3 and 3.4.4) on the S2 materials.

Table 3.4.1 Selective Stripping Using Sponge-Jet® Silver Media, S1 Panels

SOD, in	Angle, deg	Pressure, psi	v, in/sec	Nozzle	MFR, lb/hr	Strip Rate, ft ² /min	Stripping Results
8	30°	40	1.50	DVN	620	0.56	90% removal of the topcoat, some barrier damage
8	30°	40	1.75	DVN	620	0.61	90% removal of the topcoat, no barrier damage
8	30°	40	2.00	DVN	620	0.69	90% removal of the topcoat, no barrier damage
8	30°	40	1.75	DVN	620	0.62	90% removal of the topcoat, some barrier damage
8	30°	40	1.75	DVN	620	0.66	80% removal of the topcoat, some barrier damage, more significant barrier damage caused by blast overlap
8	30°	40	2.00	DVN	620	0.75	80% removal of the topcoat, some barrier damage
8	30°	40	2.00	DVN	620	0.75	80% removal of the topcoat, some barrier damage, more significant barrier damage caused by blast overlap
8	30°	40	1.75	DVN	620	0.63	80% removal of the topcoat, some barrier damage, more significant barrier damage caused by blast overlap
8	30°	40	2.00	DVN	620	0.72	70% removal of the topcoat, no barrier damage
8	30°	40	1.75	DVN	620	0.63	70% removal of the topcoat, no barrier damage
8	30°	40	0.50	DVN	620	n/a	no stripping, topcoat roughened
8	30°	40	0.75	DVN	620	n/a	no stripping, topcoat roughened
8	30°	40	1.00	DVN	620	n/a	no stripping, topcoat roughened
8	30°	40	0.25	DVN	620	n/a	no stripping, topcoat roughened
8	60°	45	2.00	DVN	620	1.02	90% removal of the topcoat, barrier damage
8	60°	45	2.00	DVN	620	0.93	90% removal of the topcoat, barrier damage
8	60°	45	2.50	DVN	620	1.13	90% removal of the topcoat, some barrier damage
8	60°	45	3.00	DVN	620	1.09	50% removal of the topcoat, no barrier damage
8	60°	40	1.75	DVN	620	n/a	no stripping, topcoat roughened
8	60°	40	1.25	DVN	620	n/a	5% removal of the topcoat, no barrier damage
8	60°	40	1.25	DVN	620	n/a	5% removal of the topcoat, no barrier damage
8	60°	40	0.75	DVN	620	0.24	90% removal of the topcoat, barrier damage
8	60°	40	0.75	DVN	620	0.21	90% removal of the topcoat, some barrier damage
8	60°	40	0.75	DVN	620	0.20	90% removal of the topcoat, some barrier damage
8	60°	40	0.75	FAN	620	n/a	no stripping, topcoat roughened
8	60°	40	0.50	FAN	620	n/a	no stripping, topcoat roughened and some barrier exposed
8	60°	40	0.25	FAN	620	0.35	both barrier and primer damaged
8	60°	40	0.50	FAN	620	n/a	no stripping, topcoat roughened and some barrier exposed
8	60°	40	0.75	FAN	620	1.02	70% removal of the topcoat, some barrier damage
8	60°	40	0.75	FAN	620	n/a	no stripping, topcoat roughened and some barrier exposed
8	60°	40	0.75	FAN	620	0.98	40% removal of the topcoat, some barrier damage from blast overlap
8	60°	40	0.25	FAN	620	n/a	stripped to substrate and primer
12	30°	40	0.75	FAN	620	0.91	95% removal of the topcoat, slight barrier damage
12	30°	40	0.63	FAN	620	0.81	95% removal of the topcoat, some barrier damage
12	30°	40	0.75	FAN	620	0.94	80% removal of topcoat, slight barrier damage
16	30°	40	0.75	FAN	620	0.96	95% removal of the topcoat, slight barrier damage
16	30°	40	0.75	FAN	620	0.95	70% removal of the topcoat, barrier damage from adjacent blast footprint
16	30°	40	0.38	FAN	620	0.45	80% removal of topcoat, no barrier damage
16	30°	40	0.50	FAN	620	0.60	90% removal of topcoat, no barrier damage
16	30°	40	0.38	FAN	620	0.48	stripped to substrate and primer

It is worth noting that during testing with this media/process combination, it was observed that the overblast associated with the fan nozzle was not as large as was observed with the double venturi nozzle in relationship to the strip footprint. It was seen that the damage to the coating system was not as severe in the overblast region of the fan nozzle. This effect from the nozzle design, coupled with the greater sophistication of the blast equipment used for this process may explain why this media/process fared better than the other sponge type media/process, since the other media/process came fairly close to producing acceptable results under different circumstances.



**Figure 3.4.3 Sponge Jet® Silver Media DMB using Double Venturi Nozzle
on S2 Test Panel with Acceptable Stripping**

Figures 3.4.5 and 3.4.6 illustrate the point that, even with the limited success of this media/process, there were instances where the selective strippability was as inconsistent as had been observed with other media/processes tested in this study. Figures 3.4.5 and 3.4.6 are photographs of unacceptable test results for S1 and S2 test materials, respectively.

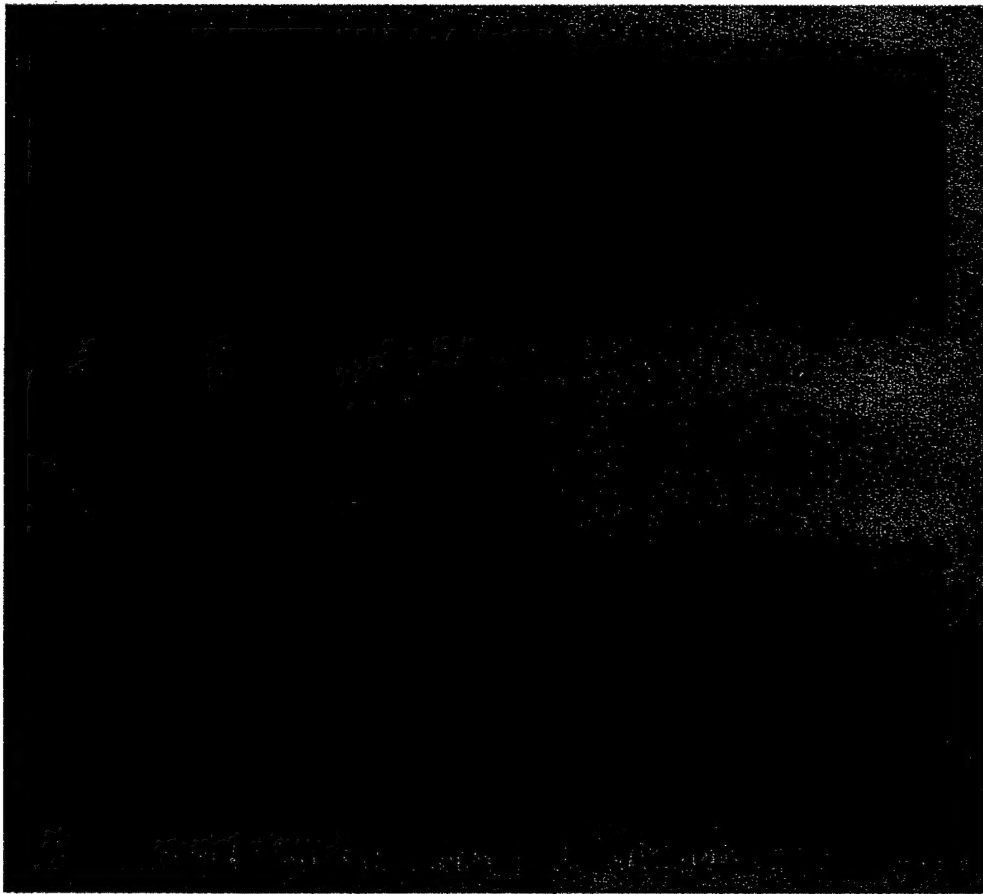


Figure 3.4.4 Sponge Jet® Silver Media DMB using Fan Nozzle
on S2 Test Panel with Acceptable Stripping

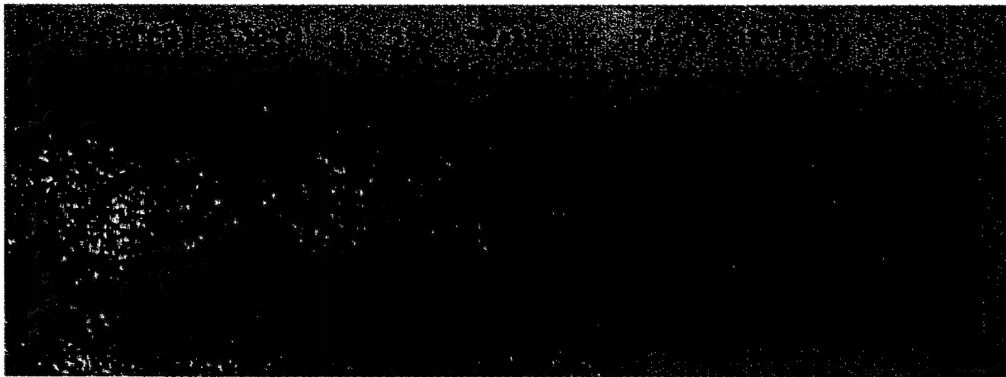


Figure 3.4.5 Unacceptable Selective Stripping
with Sponge-Jet® Silver Media, S1 Test Panel

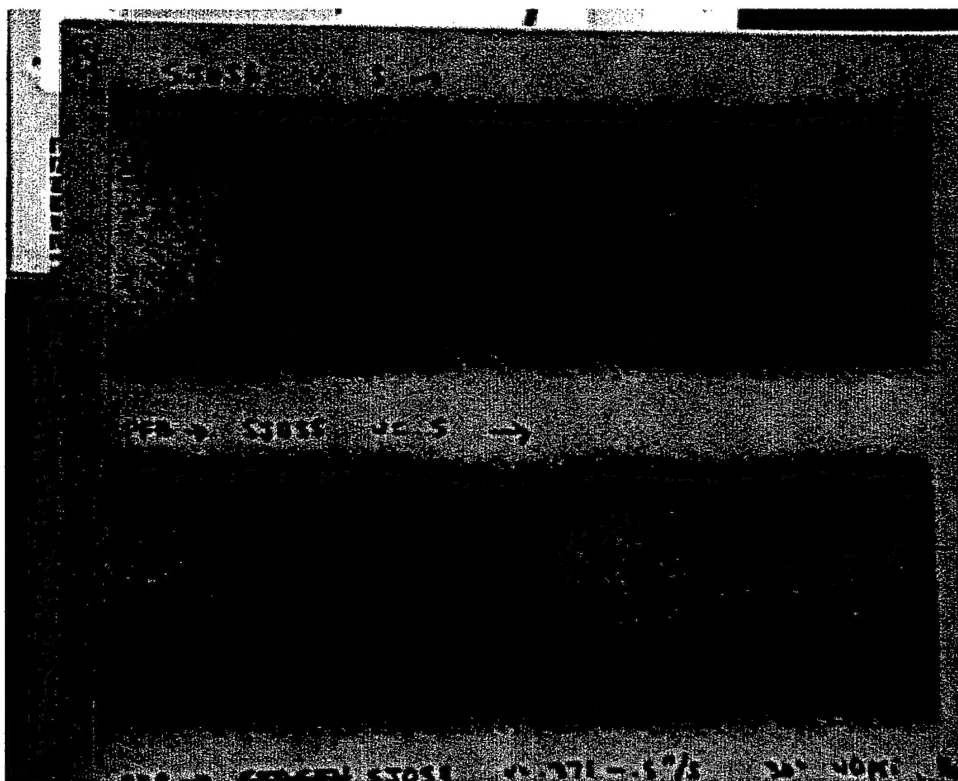


Figure 3.4.6 Unacceptable Selective Stripping with Sponge-Jet® Silver Media, S2 Test Panel

Table 3.4.2 Selective Stripping Using Sponge-Jet® Silver Media, S2 Panels

SOD, in	Angle, deg	Pressure, psi	v, in/sec	Nozzle	MFR, lb/hr	Strip Rate, ft ² /min	Stripping Results
8	30°	40	1.50	DVN	620	0.67	95% removal of the topcoat, barrier damage
8	30°	40	2.00	DVN	620	0.89	95% removal of the topcoat, slight barrier damage
8	30°	40	2.25	DVN	620	0.81	20% removal of the topcoat, no barrier damage
8	30°	40	2.25	DVN	620	0.84	20% removal of the topcoat, no barrier damage
8	30°	40	2.00	DVN	620	0.72	40% removal of the topcoat, no barrier damage
8	30°	40	2.00	DVN	620	0.73	80% removal of the topcoat, no barrier damage
8	60°	40	1.50	DVN	620	n/a	no stripping, topcoat roughened only
8	60°	40	2.00	DVN	620	n/a	no stripping, topcoat roughened only
8	60°	40	0.75	DVN	620	n/a	20% removal of the topcoat, no barrier damage
8	60°	40	1.25	DVN	620	n/a	20% removal of the topcoat, no barrier damage
8	60°	40	1.00	DVN	620	0.36	90% removal of the topcoat, no barrier damage
8	60°	40	1.00	DVN	620	0.39	95% removal of the topcoat, no barrier damage
8	60°	40	1.00	DVN	620	0.40	95% removal of the topcoat, no barrier damage
8	60°	40	1.00	FAN	620	n/a	5% removal of the topcoat, no barrier damage
8	60°	40	0.75	FAN	620	0.94	70% removal of the topcoat, no barrier damage
12	30°	40	0.38	FAN	620	n/a	stripped to substrate and primer
12	30°	40	0.75	FAN	620	0.88	80% removal of the topcoat, slight barrier damage
12	30°	40	0.75	FAN	620	0.86	80% removal of the topcoat, slight barrier damage
12	30°	40	0.75	FAN	620	0.83	60% removal of the topcoat, no barrier damage
12	60°	40	0.63	FAN	620	n/a	20% removal of the topcoat, no barrier damage
12	60°	40	0.50	FAN	620	n/a	20% removal of the topcoat, no barrier damage
12	60°	40	0.38	FAN	620	0.44	80% removal of the topcoat, no barrier damage except from overblast from an adjacent test blast
16	30°	40	0.50	FAN	620	0.66	95% removal of the topcoat, no barrier damage
16	30°	40	0.50	FAN	620	0.66	95% removal of the topcoat, slight barrier damage
16	30°	40	0.50	FAN	620	0.66	95% removal of the topcoat, slight barrier damage
16	30°	40	0.63	FAN	620	0.79	85% removal of the topcoat, no barrier damage
16	30°	40	0.63	FAN	620	0.79	85% removal of the topcoat, no barrier damage

4.0 DISCUSSIONS/CONCLUSIONS

Throughout the course of the testing conducted under this project, the results have been notably inconsistent. This also held true with the test results associated with the Sponge-Jet® Silver Media process even though this process was fairly singular in demonstrating some degree of successful selective stripping with the WR-ALC barrier coating system.

Several variables have been noted that probably have contributed to these inconsistencies. It seems plausible to state that the primary variable relates to the coating system itself. For example, Battelle Memorial Institute has developed test data that suggests that the most effective selective stripping with the water blast process is achieved after conditioning test materials with UV light, which is intended to simulate exposure to natural sunlight. The test materials used for the SwRI assessments did not undergo this conditioning. It has been suggested by Battelle that test results associated with this SwRI project may be influenced by this lack of conditioning.

Other factors such as specialized equipment and nozzle design play a role, but that role may be fairly minor in terms of the impact imposed by the coating system and media type.

However, given the issues noted above, it may be stated that a level of feasibility of use of a DMB process with the barrier coating system has been demonstrated. The inconsistencies encountered in this study make it difficult to fully determine the degree of feasibility regarding different media, process equipment, and applicability as a manual process.

5.0 RECOMMENDATIONS

Recommendations for future efforts should include an investigation into the real role that coating system aging plays in selective stripping of the barrier coating system. High levels of UV exposure are typical to only certain areas on any aircraft, and other areas such as under the wings, etc., certainly see less exposure. Therefore, for successful integration of the barrier system into Air Force operations, the effect on strippability with any process must be defined in terms of various aging conditions. A full determination of feasibility of DMB selective stripping cannot be concluded without the information about aging, since there is no point in trying to optimize the various processes, and/or the coating system for DMB applications, without resolution to the aging issues.